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Remedial strategies for the slow learner in mathematics

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REMEDIAL STRATEGIES FOR THE SLOW LEARNER IN MATHEMATICS

by

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CHAPTER I

INTRODUCTION

The slow learner in the elementary school setting is receiving more attention than in prior years. A major area of concern has been that of mathematical skills. An increasing number of children at the elementary level has shown areas of deficit in comprehension and application of basic mathematical principles. It is imperative to discern characteristics of the slow learner and the relationship of remedial strategy implementation to aid the proper understanding of mathematical constructs.

The traditional elementary classroom teacher generally follows the instructional guidelines of a mathematical textbook series. Unfortunately all students within the classroom framework do not comprehend the mathematical textbooks' behavioral objectives. The suggested modes of presentation have not been appropriate for all students in the classroom. One, two, or possibly three introductory and application exercises may not be on a practical plane of presentation for the slow learner. It has been necessary to use task analysis to aid the teaching of the slow learner. An appropriate mode of instruction other than the classroom textbook may be used as an intervention strategy. Slow learning may result from deficient affective functioning as well as deficient cognitive functioning. Therefore, remedial strategies in mathematics have been implemented to aid the slow learner.

The traditional classroom teacher, special education teacher, and elementary mathematics specialists may rely on task analysis, memory (trace) skills, and improved curriculum and instruction to enhance the slow learner's skills in regard to problems in mathematics. Remedial strategies are encouraged to incorporate not only improvement of mathematical skills, but also to enhance the self-concept of the slow learner. The slow learner may show improvement, as seen and measured through assessment devices, as in the form of criterion referenced tests. Improvement in diagnosis, teaching strategies, selection of context and materials, and a revised learning environment may encourage refined mathematical skills.

Purpose

The purpose of this research paper was to examine remedial strategies, which will aid the teachers of the slow learners in mathematics. Information related to concepts involved in teaching mathematics have been researched. Educators have been encouraged to expand their knowledge of mathematics to broaden their teaching repertoire. The slow learners have shown a need for new ideas in teaching strategies, which incorporate comprehension and usage of mathematical skills.

Scope and Limitations

Research in the area of mathematics and the slow learner has been on an upsurge within the last ten years. A higher degree of emphasis has been placed on those students who have not been able to meet the accepted criteria for maintaining grade level. However, research has identified a need for further studies in relation to the slow learner and mathematics. Strong traditional approaches in mathematical instruction for the slow learner warrant evaluation and refinement of current teaching techniques. Thorough examination of the appropriate methodology of each slow learner's needs is an accepted criterion for instruction in mathematics.

Definitions

The following definitions are of importance in clarifying terms within this research study.

Slow learner: a student who demonstrates below average capacity on the determined bases of mathematical achievement, teacher grades, reading level, I.Q. range, or various combinations of these.

Remedial strategies: variation from the traditional methods of educational, instructional methodology and presentation of materials to enhance thinking and problem solving skills.

Summary

The purpose of this paper has been to present information which will aid the mathematical instruction of the slow learner. Therefore, emphasis has been placed on the slow learner. Understanding each student's individual needs and new teaching strategies needs to be examined for the enhancement of the student's educational gains. Educators need to look for remedial strategies which may be incorporated within the traditional teaching methods or the remedial strategies that may be used alone.

The slow learner in mathematics has educational needs to be assessed. Through usage of improved diagnosis, teaching strategies, selection of content and materials and revised learning environments the slow learner may develop necessary cognitive skills for understanding mathematics.

CHAPTER II

REVIEW OF RESEARCH

Implications of Mathematical Skills

Mathematical learning is dependent upon a multitude of factors. Flinter (1979) maintained that one of a child's finest attainments in his learning experience is the concept of number--ideas of quantity, weight, time, operation, numerical classification and problem solving. These principles begin early and develop as the individual grows. The uniqueness of the individual has shown that there are many factors to be considered when dealing with the slow learner.

Problems encountered have been in isolation or in clusters. Variance has occurred in the areas of verbal disturbances, such as when the child does not understand verbal explanation of relationships. Disturbances of visual spatial organization, characterized by inability to mamipulate objects with usage of the individual's imagination or estimate distances, differences in shapes, size, and amounts resulting in judgment errors. Disturbances of reading and writing numbers, characterized by inability to relate the numerical sets of amounts to the number or its number word and mistakes in actual reading or writing of a number, for example, the number two thousand thirty-one may be written as either 231 or 200031 by the slow learner. Impairments in comprehending mathematical concepts whil performing mental calculation, are characterized by the inability to name the number of objects in a group or understand the mathematical relationships as in the areas of inequalities, greater than or less than. There are disturbances in operation, as the learner has not been able to distinguish between mathematical symbols and may add rather than multiply, showing a lack of comprehension in what skills are involved in the mathematical processes. Also confusion of place value and direction of computation may occur; that is, there is no concrete understanding of the meaning represented by the place value systems and understanding of the correct direction to be used in number reading (left-to-right) and in calculation (right-to-left). All these are directly related again to the place value system. Due to these many considerations it has been shown to be of importance to use task analysis to ascertain that mathematical instruction be on a practical plane for each student.

Kaliski (1962) stated that success or failure of teaching arithmetic will depend to a large extent upon the wording used in teaching the numerical concepts and processes. Terminology must be clarified for the slow learner. The language used by the teacher must be simple, precise, and slowly graded from terms related to the child's everyday life and the world around him to the higher, more abstract, symbolic terminology of mathematics. The language used by the slow learner in mathematics should be broadened so that there is a good knowledge level of those skills and processes which are involved in problem solutions.

Diagnosis of learning styles has shown to be an important aspect in formulating concepts directly related to seeking cause and remediation of mathematical problem areas. Educators directly involved with a student perceive a problem in mathematics, but may have a poor understanding of how to find out explicitly what it is, where the problem exists, and how to successfully remediate it. Therefore, according to Hopkins (1978), a number of other considerations are essential to a complete and accurate diagnosis. Among these essentials are the following: (1) the child's physical, emotional, and environmental conditions; (2) the level of understanding displayed by the child in the areas tested (concrete, representational, symbolic); and (3) the most effective learning style of the child.

Criterion referenced tests, such as the Key Math Test and the Metropolitan have aided in determining areas of strengths and weaknesses in mathematical understanding. Primary consideration has been given to interpreting and developing a mathematical program appropriate to the slow learner's needs. Consideration of learning styles is of primary importance. Dunlap and Thompson (1977) stated that with the diagnostic information gained to determine problem areas, instructional activities can be devised that will emphasize a particular group of facts which has not been memorized, instead of studying all of the facts in order to learn just a few. A broader range of mathematical assessments has been shown to be a good tool to monitor gains in remedial instruction, as a follow-up to diagnostic testing.

Thus far, it has been shown there are many areas to be discerned when working with the slow learners in mathematics. Swett (1978) maintained that only when a child is capable of organizing his thoughts and activities in a logical, confident way, can he or she go on to master the more abstract demands of language development. Math's many patterns and consistent structure aid the slow learner. It is dependable, This has been related to using mathematics as a skill builder in: Handwriting--uniformity in writing numbers and drawing geometric shapes; Spelling--number words used in nursery rhymes; Vocabulary--building word lists with the multitude of math terms; and Reading--to use in word problems that combine the readability level with the math ability level of the learner. Math has also shown to be an important tool in aiding the slow learner in building self-image and self-confidence from a level of failure to success. Utilization of math as a skill-developing process through games has further aided the child to attain mastery of math concepts and a heightened degree of self-image.

Memory has proven to be an integral process in learning styles. A study was conducted by Webster (1979) which investigated the existence of a significant difference in short-term memory recall capacity between children demonstrating adequate mathematics achievement and those exhibiting performance below expected grade level. Short-term memory refers to a temporary storage mechanism which holds newly acquired information until it is processed for long-term storage or to hold previously acquired information retrieved from long-term memory for use in the present. Short-term memory in combination with learning modalities appears to be of paramount importance in the learning process. The most apparent consequence of impaired short-term capacity is the potential influence on academic learning efficiency.

Further, it was found that in the absence of organically based visual defects, memory deficits related to carrying and number tables, perseveration, and failure to recognize the correct operational symbol dominated the arithmetic productions of mathematics-disabled individuals. The results of the study supported the hypothesis that atypical learners fail to use the same coding mechanisms as efficiently as adequate learners. This inefficiency appeared to result in lowered levels of achievement and learning gains. Other research by Patton and Offenbach (1978) in memory performance also showed that distractibility in memory areas was related to visual and auditory learning deficits of the slow learner. More errors occurred when tasks to be performed and the distractors were in the same modality, correspondingly affecting memory skills application.

Difficulties have been faced by slow learners in the areas of textbooks used that are not on the readability level of the students. Teachers also face the dilemma of those students unable to apply the skills and knowledge they possessed to textbooks based on too high a readability level. The task of reading mathematics language which demands accuracy and reasoning has proven to be a severe obstacle for the slow learner. Therefore, a study by Dolgen (1977) made suggestions to teach the vocabulary necessary to develop a productive learning environment through textbook adaptation. It was suggested that: (1) the teachers should pre-read a unit and list the most powerful and essential words basic to the unit; (2) words systematically chosen should be incorporated within the daily lesson plan and written assignments; (3) three to five of these words should be taught so that word structure and meaning skills are developed. Thus, there will be an improvement in application of terminology and mathematical skills by the slow learner as has been researched by Dolgen (1977). Dunlap and McKnight (1978) revealed through their research that the teacher's guidance will aid conceptualization of written mathematical problems through careful usage of textbook adaptations and task analysis to develop the appropriate mental images and concepts for association with expressions in each vocabulary.

Early studies of mathematical disabilities viewed visual perceptual and visual motor skills as critical for learning. A study was conducted by McLeod and Crump (1978) which also incorporated verbal skills to the aforementioned areas. McLeod and Crump found that there was a significant relationship among mathematics achievement, verbal ability, and visual spatial skills. Findings indicated that verbal ability variables were related more closely to mathematics achievement than visual spatial skills in the sample of youngsters selected for this study who exhibited difficulty in mathematics. Since the substance of mathematics is symbols and language, verbal ability is integral to many facets of mathematics, including concepts of quantity and classification. Hence, much of the foundation for mathematics achievement involves language concepts. Further research in this area is needed to determine the nature of the relationship of both verbal ability and visual spatial skills to mathematics achievement for the slow learner.

Concern has been expressed for the slow learner in regard to auditory-vocal deficits. Recall has been studied by Spitzer (1976) to determine the effectiveness of visual and auditory recall cues. Visual recall was determined to have better results than auditory recall regardless of cues. Therefore, it is an important issue to assess further the role of visual and auditory recall cues to the learning of mathematics for the slow learner. There have been many concerns for the slow learner in mathematics and further research in the area of auditory-vocal deficits dealing with cognitive abilities is needed.

Considerations for Remediation

The classroom teacher is often the first person to recognize a child's disability in comprehension of mathematical skills. Suggestions were made by Thornton and Reuille (1976) as an aid for the classroom teacher. They advise keeping anecdotal records on the child in question. Responses in regard to mathematical exercises and behaviors should be recorded. Careful attention should be considered by the teacher. Identified strengths should be built into each math lesson so that the student will find successful experiences. Goals set for the slow learner should be reasonable and at a level where the learner may track his own progress, as through charting his exercise response scores. If perchance the child fails to make progress or shows disinterest in a specific area, it should be discontinued for a time, then returned to later. Concrete materials in conjunction with multi-sensory approaches aid the slow learner. A special area of the classroom could be designated as a "learning center" for independent study. Learning motor activities will be an aid to hyperactive and distractible children.

For each learner, care should be given to the weaknesses, whether it be perceptual in the areas of visual or auditory, so that proper teaching approaches be utilized. The learning disabled child, like other children, profits from a careful, sequential development of mathematical ideas. The child with a learning disability in mathematics, however, may find it more difficult to reason abstractly and to think quantitatively. It is important to incorporate every day experiences into the mathematics lessons. Consistency and open communication are necessary ingredients for a success level between the classroom teacher and the slow learner.

A study was conducted by Osguthorpe and Harrison (1976) which looked at the effects of "priming" the slow learner. "Priming" for the purpose of this study was defined as pre-remedial instruction. That is, slow learners were tutored on a topic before their classmates reached it. This appeared to raise the interest and attention levels of the slow learners in class. A higher level of self-confidence was discerned among the slow learners as they were volunteering to discuss mathematical concepts in class. Also, the so-called "brightest" students were turning to the pre-remediated students for help with worksheets. It is an interesting concept, but the feasibility of a program such as this in every classroom setting is questionable.

Aides for Teaching the Slow Learner

Many concepts lay behind the studies in developing skills in mathematics for the slow learner. Eight strategies for the teacher were developed by Dogget (1978) based on the ideas of Jerome Maslow, Madeline Hunter, and Robert Gagne. The strategies suggested were:

1. Teach to a specific, predetermined objective and make directions clear and concise.
2. Emphasize an oral-verbal approach with quick cordial feedback, and plenty of positive reinforcement.
3. Capitalize on "time" as a valuable teaching and learning aid, and limit the teacher's oral presentation to ten minutes.
4. Be very sensitive to the learners' disposition, change the pace of learning to maintain or increase learner motivation.
5. Teach the learners simple organizational systems, tricks, or short cuts that will help them structure the learning for themselves.
6. Give drill and repetition variety to optimize interest retention.
7. Involve the students in planning, evaluating, and revising their own learning goals.
8. Actively solicit the support of the parents in helping students improve skills.

Dogget (1978) mentioned that according to Madeline Hunter, a learning theorist at U.C.L.A., time is the coin of teaching, and if one can improve one's skills so that math problems can be solved in less time, it is an important achievement for the learner that should not be overlooked; this is why time was noted in competencies. Student involvement in setting goals or their own growth plan has been suggested to be incorporated within the aforementioned strategies.

Developmental skills basic to the mastery of mathematics need to be attained on a concrete level before any skills on the abstract level may be understood and utilized. Thornton (1977) stated that the special child need not have special problems with basic facts. When the idea underlying an operation is understood, for example, adding means putting together, multiplication involves joining equal groups, then the use of thinking strategies and the careful selection of multisensory experiences can help children "measure up" in basic fact skills. Sharing the strategies such as adding with doubles, doubles plus one, using a matrix, or number line may aid the slow learner in developing a practical resource which may be used as substantial aid. In conjunction, dependent upon circumstances, it may be possible to develop an individualized supplemental program for the slow learner. The individualized program would accompany the textbook according to Dyer (1978). Learning packets were developed using behavioral objectives along with pretests and posttests. Under this individualized program, a new student was able to come in, take a series of placement tests and begin acquiring mathematics skills to fit the student's own particular needs.

Another example of a planned program in aiding students in making gains in computation of basic facts was studied by Adams and Schilling (1978). They found in a Louisiana School System, a substantial number of fourth- and fifth-graders who had not achieved required mastery and relied on the time honored crutch of finger counting. The teachers in this school had determined that pace was a vital concern and that drill material recorded on a tape would be the most viable means of program presentation. The program followed these design features: (1) short drill periods; (2) a great deal of repetition; (3) usage of the commutative principle; (4) involvement of a variety of senses; and (5) a pace that was easy to maintain if the students knew their facts but was difficult to maintain if the students tried to engage in finger counting. One aim of the project was to improve degree of mastery, which would presumably reduce finger counting. Data were compiled relative to the amount of finger counting evidenced during pretest and posttests. There was no control group for comparison purposes, but on the available data and testimony of participating classroom and Title I math classes, the program was very helpful to students who were working toward mastery of their multiplication facts. Sauls and Beesom (1978) also followed this line of reasoning. They stated that a meaningful aid in arithmetic becomes a crutch when the child uses it beyond the stage where he no longer needs it. For example, he may count or tap to arrive at the answer when he is capable of obtaining the answer by direct, mature means. If a child continues to use a meaningful aid in arithmetic after he no longer needs it, we must help him eliminate its use and encourage him to work at his highest level of performance.

The role of concrete or manipulative materials in developing early number concepts is crucial to the understanding of basic math skills and has been recognized by educators. Such aids are needed by most beginning learners since they generally lack the necessary maturity to deal with the arithmetical processes in an abstract manner. Studies have shown that meaningful aids are not harmful to the learner, but may actually enhance understanding and add meaning to the learning process.

Myers and Thornton (1977) stated that when a slow learner has demonstrated his understanding of the concept involved (addition, subtraction, multiplication, division), he is ready to begin the process of mastering the basic facts. Therefore, the teacher of the slow learner should keep these areas in mind for developing further skills: strategy formation and reinforcement activities (math games following the behavioral objective in question), discrimination and classification activities, overlearning activities, ability to transfer previously learned knowledge to new problem-solving activities, and integration activities which relate awareness of value of present knowledge of basic facts. Fact cluster and categorizing of activities, where developmentally appropriate, showed that short-term retention gains were encouraging and adequate gains on long-term retentions were not available. But most importantly by using task analysis in the aforementioned areas, slow learners who had repeatedly failed in their attempts to master the basic facts were experiencing new found success.

Cues which also have been of value when working with the slow learner have ben termed mnemonics. Usage ranges from learning to write numberals 0 - 9 to learning how to write a numeral in expanded notation. A prime example of mnemonics has been demonstrated for number writing, for example, the number 4 is written in this manner, go down the street, around the corner, and down the street again. Bray, Justice, Ferguson, and Simon (1977) conducted a study on the developmental changes due to the effects of instruction on production deficient children. They found that on a variety of memory tasks, young school aged children can be successfully instructed to use relatively sophisticated mnemonic strategies, yet they rarely adopt such strategies without explicit training. This observation is usually taken as an indication of a "production deficiency," meaning that the child who has the prerequisite ability for adopting a particular strategy does not do so spontaneously. There are implications that for children of a given age, different task conditions may result in either the production or nonproduction of a particular strategy. Further, if such conditions could be ordered along a continuum, it would be possible to identify the conditions necessary for priming a mnemonic strategy. It is also likely that the degree of priming necessary would change with age. The following suggestions were made for the teacher of the slow learner to incorporate into introduction of mnemonic strategies.

1. Look condition--student looks at, but is not required to remember stimuli.
2. Remember condition--student remembers stimulus, but no directions are given concerning memory strategy.
3. Label condition--student labels stimuli during familiarization.
4. Over and over condition--instruct in a label, child is required to name stimulus when presented over and over.
5. Cumulative-rehearsal condition--like labeling, add some of the first stimulus to the second for materials presented.
6. Modeling condition--pretraining like modeling, model cumulative strategy by the teacher, student copies are found to be the most effective. (p. 1019)

The aforementioned study concluded that none of these conditions "primed" a rehearsal strategy, indicating that a considerable amount of structure is required before the strategy will be adopted at varying age levels. Also, Negin (1978) stated that arguments for the use of mnemonic devices have been advanced by more than 400 writers during the last 2,500 years. Again, in essence, menmonics rely on specific learning that provides cues for the more extensive or difficult material, that is, to provide creative and enjoyable learning experiences.

Utilization of Concrete Models

Concrete materials have proven of intrinsic value to give the slow learner a firm basis from which growth may be gained from the concrete to abstract level of operations. Friedman (1978) stated that on the basis of recent research, it would appear that after the first grade, manipulative strategies have been effective in several situations, but the idea that instructional strategies give preeminence to the use of manipulatives is unwarranted. At the same time, the inclusion of the manipulative strategy in an instructional repertoire should be urged. Common sense, however, seems to dictate the use of manipulatives as concrete aids whenever necessary and should not be limited to their main value as a resource during first grade.

Guides for selection of concrete models should be used on four criteria according to Sowder (1976). He stated that: (1) the representation should force pupils to attach meanings to the symbols; (2) the representation should be mathematically honest and not too phoney or contrived; (3) the representations should, if possible, be adapted to more advanced, related work; and (4) if the topic will eventually lead to an algorithm, the interpretation should suggest the algorithm or, second best, give answers that might suggest an algorithm. Representations should be in pictorial form. Material has been presented to children enrolled in the Title I (Elementary and Secondary Education Act) Mathematics Project in Milwaukee, Wisconsin, on three levels: concrete, pictorial, and abstract. Through presentation of materials in these areas, on a task analysis basis, students have shown growth as determined through usage of the Metropolitan as a pretest and posttest along with monitors throughout the school year.

On a practical plane of usage for concrete materials, Danforth (1978) has suggested several strategies for good teaching practices. Practical usage of concrete models with the following suggestions is dependent upon the logistics in each classroom setting. (1) Give a concise statement of the specific objective for each session. Making the student aware of what is going to be covered in class is important. (2) Have the student verbalize his thought process in working specific problems. Through listening to the student verbalize his thoughts while problem solving, a higher calibre of remediation may occur. (3) Keep an error-analysis card. This record has been used to track the pattern of errors which have developed. (4) Use analogies to emphasize numerical relationships. Usage of analogies promotes two areas--first, logical thinking towards problem solving techniques, and second, usage for visual reference. (5) Present directions in several different ways. Oral repetition by slow learners is important to determine their comprehension. (6) Use concrete materials and real-world situations for presentation of a lesson. Preparation of practical life activities is an important aspect in mathematics. (7) Develop aids for avoiding errors. It has been shown that in some learning situations, usage of color-coded visual aids helped the slow learner to make the necessary transitions in thinking for computation. (8) Remove frustration from the learning situation. Successful experiences in mathematics for the slow learner are important not only in the gain of mathematical skills, but improvement in self-image. Another consideration for the slow learner developing problem solving ability is patterning. Silvia (1977) reported a study which found that for the young child, a successful experience in mathematics may be developed through the use of patterns. A brief observation of children's play revealed a natural tendency to look for patterns or regularities in their surroundings. As usual, the best point of departure for having them form sequences is at the figural level. That is, the child's earliest directed involvement with sequences should use concrete objectives such as, geometric shapes, counting sticks, colors, or arrays of prime numbers.

Specific Consideration for Remediation Strategies

Behavioral objectives need to be formulated to establish the educational goals for the slow learner. Walbesser and Carter (1972) found that if a teacher describes his objectives for the slow learner in terms of observable behavior, than he increases the likelihood of being successful in teaching them. It is important to have made use of verbal limitations through terminology, such as, solve, make, write an answer, identify, give a rule, define, subtract, know, prove, write a name for, add, compute, substitute, and estimate, to name a few. Clarity and conciseness are of the utmost importance.

One of the most important facts revealed by educational assessment in mathematics instruction is the wide range of achievement levels that has been shown in any class in our schools. According to Junge (1972) quoting Cruickshank, the slow learner resembles the average and the above average student in general physical development, chronological age, and interests common to his age group, but may not learn intellectual things at the same rate as other children, owing either to lack of potentiality or to personal and emotional factors that interfere with the ability to achieve. Further research in their study dealing with slow learners showed that: (1) they are reasonably like other children in areas of computation, although they are more careless than average children and use more "primitive" habits, such as, making marks and counting on their fingers; (2) have greater difficulty in identifying and understanding which process should be used in problem solving; (3) lack skill separating irrelevant facts from the significant dimensions of a problem; and (4) have greater difficulty with reading and language peculiar to mathematics. Therefore, learning difficulties and determining readiness for new learning has been suggested by Junge (1972): (1) observe the child at work; (2) interview the pupil; (3) analyze written work; and (4) use tests as clinical tools. The tests may be in the form of standardized, diagnostic, teacher made, or diagnostic assignments.

The aforementioned study suggests three ways of providing a setting in which children have an opportunity to realize their full potential. The first is through special forms of classroom organization; the second is through curriculum adjustments; and the third requires special instructional adjustments by the classroom teacher.

Beneficial results have occurred through organization of the classroom for learning as through homogeneous grouping, math laboratories, independent study centers, carrels, nongraded team teaching, and computer assisted instruction. Pearson's (1972) research indicated that the physical characteristics of the environment would include an open, flexible atmosphere, incorporating mobility, small group work, areas with games, audio-visual equipment and a math activity file. Usage of the bulletin boards and chalkboard has shown to be a viable learning tool. Structure is of the utmost importance to the slow learner. An established routine within the classroom has shown to be helpful. Also the slow learner is in constant need of reassurance and some signs that his efforts will be rewarded and successful. The teacher's positive control of the environment has shown to have favorable outcomes for the slow learner.

Curriculum adjustments are necessary for the slow learner. Junge (1972) suggested that: (1) the curriculum be well structured and systematic as well as paced to the individual's level of maturity; (2) it should establish a minimal program which includes new approaches to computation, new treatment of traditional topics and selected new topics; (3) it should make wide use of visual and manipulative materials progressing toward abstract representation, but at a more deliberate pace than for average and above average pupils; (4) it should give special help on the vocabulary of mathematics; (5) it should include instructions on how to locate information, how to use the textbook, how to study, how to remember, and how to check computation; and (6) it should relate mathematics to other curricular areas, particularly to science, social studies and art (p. 130).

Junge (1972) also mentioned specific strategies for instructing the slow learner. There is a practical need for familiar experiences. The slow learner is not helped by mere repetition, but by an enlarged view, carefully developed. This is better than endless review and repetition. Due to the vocabulary, instruction is necessary to key into the reading of mathematics. Reading in mathematics has a few variables: careful attention to detail; a questioning; reflective frame of mind; and a familiarity with the usual, more general, vocabulary and symbolism. Intra-class, or within-class, grouping of students is one of the more successful ways of adjusting instruction to the needs of the slow learner.

Due to the fact that the slow learner is likely to be a physical rather than abstract learner, he is unable to use abstract symbols, he needs models and aids that can be made, touched, manipulated, and examined. Inclusion of multisensory aids should be used to teach mathematics. Maletsky (1972) has stated several uses of manipulative models. They may be used to develop number patterns as the slow learner needs visual aids to give meaning to mental activities, for example, cut paper, cut string, fold a paper square, strip or triangle. Aid in maintaining mathematical skills is seen as through materials aiding the mastery of basic facts. These items include: card games, magic square, display cards and flow charts. Geometric constructs along with concepts of length, area, and volume may be mastered through usage of sketch solids, geometric shape forms, congruent figures, grids, and graph paper. Actually usage of simple items such as folding paper, graph paper, overhead projectors, chalkboard and bulletin boards are beneficial.

When teaching computation, an obvious strategy for helping the child with a short attention span is to keep all the verbal instructions to a minimum. Actual student involvement is also a key to develop computational skills. Schulz (1978) listed several strategies to aid instruction in computation skills. The slow learner's verbalization of solutions to computation aids the self-direction provided by the sound of the child's own voice to help maintain attention to the task. Also the child's thoughts are more clearly organized through a step-by-step procedure, along with aid for the teacher diagnostically as the child reveals thought processes used. To assimilate mathematical goals, students can recall the proper sequence of steps required in an algorithm once they understand the process and can perform each individual step. Again, as with all memory problems, practices are most beneficial. However, unless the students are practicing the correct procedures, practice is useless, if not detrimental. For this reason it is important that the slow learner be provided with cues that will ensure correct performance.

Commercial and teacher made resources are available from a variety of sources. There are vast amounts of materials available to work with the slow learner in mathematics. Therefore, examples of various activities, games, and their applications were taken from a study conducted by Rowan and McKenzie (1972). First, Magic Squares was developed to review addition and subtraction facts. A paper is divided into nine squares. A different number is in each square. Sums are written in the farthest right vertical squares, and bottom row of horizontal squares. Numbers 1 through 9 are used. Second, Palendronic numbers are reversable numbers added together. Select a number, then reverse the digits and add them. Third, the lattice method of multiplication is of value. The student practices primary multiplication plus addition facts, and does not have to rename during the multiplication process. This procedure works due to the Distributive Principle. Fourth, mathematical mind reading is an interesting activity to involve the slow learner. It is done as follows, using numbers 1 through 9. Write a number between 1 and 9 (the number of brothers you have), double the numbers answer, add 1, multiply by 5, add the number of sisters you have, then tell your result orally, subtract 5 and the number of brothers will be in the tens place and number of sisters will be in the ones place of the resulting answer. Fifth, the mobis strip is interesting in design. A strip of paper, such as adding machine tape, is held. One end is given a half twist, then the edges are taped together. The discovery process occurs when the student is asked to color one side red and the other side blue--this cannot be done. This may be tried with the strip cut in halves or thirds with the same result. Sixth, probability is examined to use discovery as a method to predict the outcome for certain events. A coin is tossed and the student checks and then records the outcomes as heads or tails. Die rolls may also be tabulated to determine which number 1 through 6 occurs most frequently.

Summary

Concepts crucial to the learning of mathematical skills by the slow learner should be carefully evaluated by educators. Complications which delay learning must be diagnosed with utmost caution and concern. Vocabulary, symbols, and reading levels need to be broadened to encourage educational growth. Consideration for memory skills should not be overlooked in dealing with the slow learner. Mathematics has the ability to use task analysis to effective degrees in aiding consistency of patterns and structures beneficial to the individual with special needs. Visual perceptual and visual motor skills should not be overlooked as they are critical to learning. Also auditory-vocal deficits are pertinent to learning and must be given careful thought by the educator while designing necessary remediating strategies.

Since the classroom teacher is most often the first person to see a problem in mathematics, it is necessary to provide aid through strategies to that teacher. Suggestions for teaching vary in format and degree. Each student, teacher, and materials available control the school environment. It is crucial that the lessons be presented in a sequential manner to the slow learner. That is, the lesson's best applications come when working from the concrete-to-pictorial-to-abstract levels of operation. It is worth noting that crutches in problem solving should be eliminated when the slow learner is capable of the internal mental calculations. Cues may be provided as an indicator of mathematical operations to take place. With proper structure these cues may be internalized.

Selection and usage of concrete manipulatives should be done with care to ascertain that they are following the lesson's behavioral objectives. Verbalization by teacher and student in the usage of these manipulatives increases their worth. Success through manipulatives and patterning skills is worth investigating. The success the slow learner may obtain through usage of concrete models is well worth the time it takes for the teacher to develop them.

Careful, logical thought progression is a necessary ingredient for both the teacher and slow learner dealing with mathematical concepts. Stated behavioral objectives should have been developed to reach the key needs of the slow learner. This is especially necessary due to the special needs of the slow learner as opposed to the average or above-average functioning student. The structure of the learning environment needs to be monitored as they vary from the actual classroom setting to means of instruction. This leads to suggested textbook adaptation by the teacher, introduction of how to read a math problem and what to look for, plus actual student development on a level which may in some instances stimulate practical life exercises. Also extremely crucial to the learning experience is the incorporation of various resources into mathematics remediation. Teacher-made or commercial activities and games provide immediate reinforcement for skills taught and should not be overlooked.

Although current research is expanding in the area of the slow learner in mathematics, it is important to look for, read, and take the time to think of materials discussed. Good practical and logical ideas are discussed and are an invaluable resource when seeking sources for help in teaching the slow learner.

CHAPTER III

SUMMARY AND CONCLUSION

Consensus of Findings

Most research dealing with the slow learner has been theoretical and it has come as no real surprise that a small amount of organized information has resulted from it. The history of research on the slow learner approximately parallels the history of the development of the concept of intelligence as quantifiable. Indeed, it appears that the first modern interest in slow learners began when researchers learned that individuals differ in intelligence as measured by standardized tests and identified slow learners as those who have scores below the average on intelligence tests. Present educational involvement with the slow learner indicates that the definition concerning a slow learner in mathematics includes demonstration of below average capacity on the determined bases of mathematical achievement, teacher grades, reading level, I.Q. range, or various combinations of these.

There is a potential for educationally mislabeling a child's skill by using a general-ability measure as a predictor for student success on a specific learning task. A more fruitful approach, bringing with it progress in the understanding of the problems of the slow learners in math, is to consider specific learning aptitudes of slow learners and to adapt instruction to take account of these individual differences. It is in this direction that potentially fruitful programs of research on the slow learner in mathematics are identified.

For remedial mathematics instruction to be successful, especially at the elementary school level, the teachers must take cognizance of the variations in the groups taught. Then assignment of expectation to the individual pupil instead of groups of pupils may take place. Readiness for learning must be determined, learning difficulties diagnosed, and the classroom organization and environment made conducive to learning. Instructional materials commensurate with the needs of the children should be provided and teaching strategies employed that will help each pupil perform learning tasks in which success will be found. There is no single, easy solution in the education of the slow learner in mathematics. The problem may be complex. Teachers must take this into account.

Promising programs are developing, along with new methodology--which is being presented to educators. This is a significant plus for the slow learner. It should be acknowledged that the good instruction presently used and in the future is invaluable for the slow learner as well as the normal child. In actuality, the teacher who can analyze a computational skill in terms of its intrinsic elements, determine the pupil's proficiencies with regard to those skills, and then present instruction geared to developing the appropriate skill will be an immeasurable asset to the slow learner. However, such teachers, be they classroom or speciality, may find that they must go beyond the usual good teaching principles and examine carefully the underlying learning processes that the child brings to the instructional situation. This may result in a success factor for both teacher and student.

Summary

Gains are being made in favor of the slow learner. Research in the area of mathematics and the slow learner is receiving more attention than in areas previously studied. The availability of further information into the difficulties encountered by the slow learner will aid instructional goals.

A higher calibre of efficiency in behavioral objective outcomes may be seen with a more effective degree of teacher awareness of problems present within the individual. Management should be used to safeguard the incorporation of individual needs within group need for instruction. Flexibility within the education system is a viable commodity. Care, love, and concern are evidenced by a growing awareness and development of remedial strategies for the slow learner in mathematics. Continued research in this area will be a positive benefit for all.

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